Citation:

Villegas R, Shu XO, Gao YT, Yang G, Elasy T, Li H, Zheng W. Vegetable but not fruit consumption reduces the risk of type 2 diabetes in Chinese women. *J Nutr.* 2008 Mar;138(3):574-80.

PubMed ID: 18287369

Study Design:

Prospective Cohort Study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To examine the association between fruit and vegetable intake and the incidence of type 2 diabetes in a population based prospective study of 64,191 women with no history of type 2 diabetes or other chronic diseases at study recruitment and with valid dietary information.

Inclusion Criteria:

- Women aged 40-70 years
- Approved by Institutional Review Boards of all institutes involved in the study and all participants provided written, informed consent.

Exclusion Criteria:

- Refusal
- Absence from enrollment period
- Health, hearing, and speaking problems
- Women aged <40 or >70 years at time of interview

Description of Study Protocol:

Recruitment :The Shanghai Women's Health Study recruitment protocols were followed.

Design : Prospective cohort study

Blinding used (if applicable): not applicable

Intervention (if applicable): not applicable

Statistical Analysis

- During 297,755 person-years of follow-up, 1608 new cases of type 2 diabetes were documented.
- Of the 1608 self-reported cases, a total of 896 participants met the study outcome criteria and are

referred to the confirmed cases of type 2 diabetes. The analysis of both the confirmed and probable type 2 diabetes cases found similar results.
- Person years of follow-up for each participant were calculated as the interval between the baseline recruitment to the diagnosis of type 2 diabetes censored at death or completion of the second follow-up survey.
- The Cox proportional hazards model was used to assess the association of fruit and vegetable intake the incidence of type 2 diabetes.
- Food groups (g/d) were categorized by quintile distribution, with the lowest quintile serving as the reference.
- Tests for trend were performed by entering the categorical variables as continuous parameters in the model
- The log-likelihood ratio test was used to evaluate multiplicative interactions between fruit and vegetable intake and categories of BMI, WHR, and physical activity.
- All analyses were performed using S.A.S (version 91) and all tests of statistical significance were based on 2-sided probability.

Data Collection Summary:

Timing of Measurements

- A biannual, personal follow-up for all living cohort members was conducted via in-home visits from 2000 to 2003 and from 2002 to 2004, with a response rate of 99.8
- Usual dietary intake was assessed by in-person interviews using a validated Food Frequency Questionnaire at the baseline recruitment survey, and again at the first follow-up survey.
- Anthropometric, physical activity, and sociodemographic factors were determined at the baseline recruitment survey

Dependent Variables

- Incidence of type 2 diabetes was identified through the follow-up survey by asking study participants whether they had been diagnosed by a physician as having diabetes since the baseline recruitment and asking about their glucose test history and/or use of hypoglycemic medication.
- A case of type 2 diabetes was considered confirmed if a participant having been diagnosed with type 2 diabetes and met at least 1 of the following criteria as recommended by the American Diabetes Association: fasting glucose elevation≥ 7mmol/L on at least 2 separate occasions; an oral glucose tolerance test with a value of ≥ 11.1 mmol/L; and/or use of hypoglycemic medication (insulin or oral hypoglycemic drugs).

Independent Variables

- Fruit and vegetable intake: dietary intake was assessed by in-person interviews using a validated Food Frequency Questionnaire.
- The means of the daily intake of individual (g/d) were summed to compute total fruit and vegetable intake.
- The Chinese Food Composition Tables were used to estimate energy intake (kj/d) and nutrient intakes.

Control Variables

- Age
- Level of education
- Family income in yuan/y
- Occupation
- Smoking-smoked at least 1 cigarettes per day for > 6 months continuously

- Alcohol consumption (ever drank beer, wine, or spirits at least 3 x per week)
- Presence of hypertension at baseline was collected by using a structured questionnaire
- Weight, height, and circumferences of waist and hips were taken at baseline recruitment according to a standard protocol by trained interviewers who were retired medical professionals. From these measurements, the following variables were created: BMI (weight in kilograms divided by the square height in meters and Waist to Hip Ratio (WHR) calculated as waist circumference divided by hip circumference.
- A detailed assessment of physical activity was conducted using validated questionnaire. The questionnaire evaluated regular activity and sports participation during the last 5y, daily activity and daily round trip commutes to work. The metabolic equivalents (MET) were calculated for each activity using a compendium of physical activity values. Each of the exercise and lifestyle activities was combined to derive a quantitative estimate of overall nonoccupational activity

Description of Actual Data Sample:

Initial N: 74,942 women

Attrition (final N): 64,191 women

Age: 40-70 years

Ethnicity: Chinese

Other relevant demographics:

Anthropometrics

Location: Shanghai, China.

Summary of Results:

Key Findings:

- During 297, 755 person-years of follow-up, 1608 new cases of type 2 diabetes were documented.
- Quintiles of vegetable intake and type 2 diabetes were inversely associated
- The relative risk for type 2 diabetes for the upper quintile relative to the lower quintile of vegetable intake was 0.72 (95% confidence interval: 0.61 - 0.85, P < 0.01) in multivariate analyses
- Individual vegetable groups were all inversely and significantly associated with the risk of type 2 diabetes
- Fruit intake was not associated with the incidence of type 2 diabetes in this population.

Other Findings

- A higher intake of fruit was associated with younger age, higher physical activity, higher educational achievement, being employed, and higher household income.
- A higher vegetable intake was associated younger age, higher physical activity, higher BMI, higher Waist to Hip Ratio (WHR), presence of hypertension, and nonsmoking status.

Table 1: Age standardized characteristics of participants of the SWHS stratified by fruit and vegetable intake[1]

	Fruit quintiles					Vegetable quintiles				
	01	02	*03*	04	05	01	02	03	04	05

n	12,840	12,842	12,820	12,853	12,836	12,838	12,839	12,833	12,843	12,838
Age, y	53.9	51.7	50.6	49.9	48.8	53.0	51.1	50.5	50.3	50.0
Dietary factors										
Energy, kj/d	6301.8	6650.8	6886.1	7100.6	7605.9	6069.8	6556.3	6891.6	7220.1	7832.5
Vitamin C mg/d	56.7	72.5	85.6	100.5	133.9	47.3	67.5	83.6	103.2	147.7
Vitamin E , mg/day	10.4	12.2	13.4	14.6	17.1	9.5	11.7	13.2	15.0	18.3
Carotene, µg/d	1921.4	2406.2	2812.4	3255.7	4166.7	1568.8	2232.5	2736.3	3340.5	4684.1
Fiber, g/d	7.8	9.4	10.6	11.9	14.5	7.5	9.2	10.5	11.9	15.1
Meat intake,[2] g/d	55.5	62.1	65.4	67.8	73.0	52.5	80.4	84.8	69.9	76.2
WHR ≥0.85%	20.3	19.4	18.7	18.6	20.2	19.7	19.3	18.6	19.4	19.7
BMI %	23.4	23.6	23.8	23.9	24.2	23.6	23.6	23.8	23.8	24.1
≥23	54.6	54.7	56.5	57.5	61.4	52.2	54.7	56.3	58.1	62.3
≥25	32.0	30.4	32.1	32.1						

Author Conclusion:

In this large, prospective, population-based study of middle aged Chinese women, higher intake of vegetables was associated with a reduced risk of type 2 diabetes. Fruit intake and type 2 diabetes risk were not associated.

Reviewer Comments:

Participants in the (Shanghai Women's Health Study) SWHS were a representative sample Chinese, middle-aged female population in Shanghai, China. The prospective design, high participation rate, and high follow-up rates minimized the possibilities of selection or recall bias.

Authors note the following limitations:

- *The study's most important limitation was the reliance on self-reports of type 2 diabetes*
- *Colinearity may have limited the ability to sort out the factors responsible for the vegetable and diabetes association.*
- *The exact benefit of fruit and vegetable intake is very difficult to assess when multiple factors may also be contributing a beneficial effect and protecting participants from developing type 2 diabetes.*
- *Fruit and vegetable consumption may act as a marker for a healthy lifestyle and healthy dietary patterns in general.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**		Yes
	1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
	1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
	1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**		Yes
	2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
	2.2.	Were criteria applied equally to all study groups?	Yes
	2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
	2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**		N/A
	3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
	3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
	3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
	3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A
	3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A

	3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**		Yes
	4.1.	Were follow-up methods described and the same for all groups?	Yes
	4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
	4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
	4.4.	Were reasons for withdrawals similar across groups?	Yes
	4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**		N/A
	5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
	5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
	5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
	5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
	5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**		Yes
	6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
	6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
	6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
	6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
	6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
	6.6.	Were extra or unplanned treatments described?	N/A
	6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
	6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A

7.	**Were outcomes clearly defined and the measurements valid and reliable?**		Yes
	7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
	7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
	7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
	7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
	7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
	7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
	7.7.	Were the measurements conducted consistently across groups?	N/A
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**		Yes
	8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
	8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
	8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
	8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
	8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
	8.6.	Was clinical significance as well as statistical significance reported?	Yes
	8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**		Yes
	9.1.	Is there a discussion of findings?	Yes
	9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**		Yes
	10.1.	Were sources of funding and investigators' affiliations described?	Yes
	10.2.	Was the study free from apparent conflict of interest?	Yes